NASA CR-175204

REMOTE SENSING TRAINING FOR CORPS OF ENGINEERS PERSONNEL

The University Training Module Concept

James R. Groves and
Robert M. Ragan
Remote Sensing Systems Laboratory
University of Maryland
College Park, MD 20742

Technical Report No. 6

August 1982

Final Report for Period July 1981 - July 1982

Prepared for

GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
REMOTE SENSING TRAINING FOR CORPS OF ENGINEERS PERSONNEL: THE UNIVERSITY TRAINING MODULE CONCEPT	August 1982
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
James R. Groves and Robert M. Ragan	

9. Performing Organization Name and Address	10. Work Unit No.
Remote Sensing Systems Laboratory University of Maryland College Park, MD 20742	11. Contract or Grant No. NAS5-26650
	13. Type of Report and Period Covered Final Report for Period July 1981-July 1982.
12. Sponsoring Agency Name and Address Goddard Space Flight Center Greenbelt, MD 20771 Technical Monitor: Janette C. Gervin	14. Sponsoring Agency Code

15. Supplementary Notes

Prepared as part of the joint Corps of Engineers/NASA Program in Water Resources

16. Abstract This report describes a concept to permit Corps of Engineers personnel to obtain and maintain an appropriate level of individual proficiency in the application of remote sensing to water resource management. Personnel will be trained at regional university training centers. Recommendations are made for specific training courses and include structure and staffing requirements, syllabi and methods of operation, supporting materials, and procedures for integrating information systems management into the University Training Modules. The concept described will provide initial, refresher, and update training that will have a number of advantages over the current course training program of the Corps.

17. Key Words (Selected by Author(s))	18. Distribution Statement
Geographic Information System, PROSPECT, Remote Sensing, Remote Sensing Symposium, University Training Module	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified		

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

TABLE OF CONTENTS

I. INTRODUCTION

The U.S. Army Corps of Engineers (USACE) has long recognized the importance of remote sensing and is firmly committed to the use of this growing technology to supply information necessary to accomplish their water resources mission. As remote sening technology has evolved, the expertise of the Corps has kept pace, making use of aerial photography, in-situ sensors, ground and airborne radars, and, most recently, satellite remote sensing platforms (Gay, 1982).

While the acceptance and use of some forms of remotely sensed data have become commonplace, the potential benefits of satellite based sensing have not yet been completely realized. There are technological issues to be addressed and solved before the full potential can be achieved. There is also a need for well designed and managed training programs that will provide field office personnel with a sound understanding of the concepts and applications of remote sensing as related to their problems. Indeed, until field personnel have an understanding of and a confidence in remote sensing capabilities, they are not going to fully adopt this new technology. Education, successful demonstration projects, and command emphasis will all be needed if the real benefits of remote sensing are to be achieved.

Remote sensing technology is both new and dynamic. Skills are needed that were unknown when most practicing engineers received their formal education. The pace of new developments is such that the technology of this year will be inefficient or even obsolete within a few years.

The information acquired through remote sensing is usually most effectively employed in combination with ancillary data such as that of soil surveys, census records, topographic maps, and similar resources. Computer based spatial data management, or geographic information systems (GIS), constructed by coding and referencing such data to locations on the earth's surface are extremely powerful tools when used in conjunction with digital

format remote sensing. The HEC-SAM system developed by the Hydrologic Engineering Center (Davis, 1982) and the Hydrologic Analysis Program (HAP) developed at the University of Maryland by Fellows and Ragan (1980) are two such systems. It is essential that all training in remote sensing applications include GIS concepts so that the data can be effectively and efficiently used (Weinstein, 1981; Ragan, 1982).

This report describes an innovative concept which will permit Corps of Engineers personnel to obtain and maintain an appropriate level of individual proficiency in the application of remote sensing to water resource management. Recommendations for staffing, syllabi and conduct of University Training Modules are presented.

II. UNIVERSITY TRAINING MODULES

A. Remote Sensing Training and Activities Within USACE

The remote sensing program of the Corps consists of three phases: program coordination, sensor selection and testing, and data integration (Jarman, 1982). Program coordination seeks to identify the needs of the Corps in data collection. Research programs at USACE laboratories and universities are involved in the selection and testing of sensors. The data integration phase addresses both technical and managerial problems of using the data.

Specific actions to facilitate more independent use of remote sensing have included the appointment of Remote Sensing Coordinators (RSC) in each field office, conduct of several short-course training programs, conduct of Remote Sensing Symposia in 1979 and 1981, and sponsorship of a series of demonstration projects with individual field offices. The Remote Sensing Application Guide (RSAG), Engineer Pamphlet 70-1-1, was published as a comprehensive reference for planning purposes and for conducting Corps-related remote sensing applications (USACE, 1979). The RSAG will be updated as required to provide users with the latest information on all available technology.

The RSC at each Division, District, and Laboratory Office serve as a focus for information and communciation exchange and facilitate remote sensing technology transfer within the Corps. They usually have other organizational responsibilities and their backgrounds in remote sensing vary widely. The RSAG is designed to provide practical technical and management guidance to the RSC and other personnel of the field offices.

The Corps has sponsored a number of short courses of training/instruction for RSC and for other personnel participating in remote sensing demonstrations and applications projects. Several such courses are listed and managed under

the Corps of Engineers Sponsored Short Course Technical Program (PROSPECT) administered by the Huntsville District (Appendix A). The courses have been conducted on a need basis through one-time contracts with universities. While these courses have been successful with respect to providing needed material, scheduling has been a serious problem and frequently results in underutilization of training spaces. Also, the contracting procedures used have not been sufficiently flexible to provide opportunities for followup interaction and updating of skills.

Many Corps personnel have received equivalent training in similar courses previously conducted by regional remote sensing application centers of the National Aeronautics and Space Administration (NASA)(Weinstein, 1981). The three NASA regional centers are located at Goddard Space Flight Center in Greenbelt, Maryland; the Earth Resources Laboratory at NSTL Station, Mississippi; and the Ames Research Center at Moffett Field, California. It appears that these centers will continue to provide assistance to users of NASA satellite data but may not be able to conduct training courses in the future because of budgetary limitations.

The Corps conducted three-day Remote Sensing Symposia in 1979 at Reston, Virginia, and in 1981 at Nashville, Tennessee. The primary purpose of these meetings was to promote a better understanding of remote sensing technology and its effective applications. These symposia included technical papers dealing with new or innovative techniques and methodologies, advanced sensor and data acquisition system design, and advanced data processing analysis capabilities. There were also interdisciplinary poster sessions documenting the operational use of the technology on discipline or mission-oriented projects. Although primarily attended by USACE personnel, these meetings attracted a sizeable

number of participants from other Federal agencies, universities, state and local government, and industry. Section III of this report describes the 1981 Symposium.

The Water Resources Support Center (WRSC), USACE, has actively solicited the participation of the field offices of the Corps in demonstration projects involving the operational use of remotely sensed data. When suitable ongoing projects have been identified by the field offices, WRSC and NASA personnel, the latter acting through their technology transfer program, have assisted in the orientation of personnel of the field offices and in the actual integration of the remote sensing data into the project effort. These demonstration projects have been highly visible and successful remote sensing applications.

The remote sensing program of the USACE was critically assessed by the Panel on Remote Sensing for Water Resources, Space Applications Board, National Research Council, in 1981. The panel concluded that extensive use of remotely sensed data from satellites by the Corps reflects an effective process for applying new technologies. Among a series of recommendations presented by the panel is one specifically related to remote sensing training (NRC, 1981):

> The Corps' work in demonstrating remote sensing to its field offices and its assistance to Corps users in the field are very useful. It would be to the Corps' advantage to expand these demonstrations and training activities to Corps' contractors and to state, local and regional governments.

B. USACE Training Needs

To be successful, training modules must meet the objectives of providing the needed skills and, at the same time, being consistent with the character of the organization and its established training programs. The training modules must also be consistent with the background of the individual trainee and must meet the needs of their current and anticipated job responsibilities.

Profiles of prospective remote sensing trainees were generated by a review of course evaluations of previous short courses, discussions with personnel from several field offices, discussions with university personnel with extensive experience in the field, and discussions with instructional personnel of a major Corps teaching agency, the Hydrologic Engineering Center. It was immediately apparent that the background and needs of individuals varied widely and that more than one course of instruction would be required.

Analysis of the needs of the Corps yields three general levels: managers require general concepts and understanding; RSC and personnel involved in designated projects required detailed knowledge; and project personnel who will be manipulating digital data or, more probably, supervising contractors require specialized knowledge. Within these levels there will remain ranges of training requirements resulting from differences in the background and experience of individual trainees. It is believed, however, that instruction should be designed and planned at these levels with an inherent requirement, as will be described below, to tailor the individual courses to meet the background of the trainees. Hill (1981) describes a pre-course questionnaire designed to facilitate the tailoring.

The current PROSPECT training courses provide for a manager course of 24 hours, a fundamentals course of 40 hours, and an advanced course, for which the fundamentals course is a prerequisite, of 40 hours. The manager course requires no specific subject matter background and is intended for senior (GS-13 and above) personnel who have management responsibility in the areas of planning, engineering, or regulatory functions. The other two courses are designed for mid-range (GS-07 thru 12) personnel who are, or will be, involved in the acquisition, interpretation, and applications of remote sensing data (USACE, 1979).

There is evidence of difficulty in achieving the objectives of the advanced processing and analysis course. There are relatively few requirements for this course and the most recent class in May of 1981 only filled five of 17 available spaces. While the course is designed to provide advanced training and "hands-on" experience in processing and analyzing multispectral scanner data, several of the trainees felt that it was unnecessarily duplicative of the fundamentals course. Trainees asked for data base management (HEC-SAM) coverage and for more "hands-on" time.

In view of the limited requirement for the advanced course and the project-specific requirements of personnel who would attend, such a course is not included within the proposed University Training Module concept. Individuals in that category of needs can best obtain the necessary hands-on experience through supplementary periods associated with the fundamentals course. The Laboratory for Applications of Remote Sensing (LARS), Purdue University, uses such optional training periods in their regular short-course offerings (LARS, 1982). With advanced coordination it should be possible to use project-specific data in the supplementary training periods, further increasing the payoff for the trainee.

As previously discussed, it is important that all modules include instruction in the manipulation and use of remotely sensed data in a spatial data management system. Such an integrated system is essential to obtain maximum benefits of the large volumes of data that will be involved. The development of such systems is described by Moore (1982).

The training needs and proposals reported herein can be expected to change with time. The contents of the module for managers will eventually have to be adjusted as individuals who have received specialized or short-course

training rise to managerial positions. As universities incorporate remote sensing instruction at the graduate and/or undergraduate level, there will be changes in the fundamentals module. More emphasis will be placed on refresher training and the dissemination of information on new technology and developments.

C. The University Training Module Concept

The University Training Module (UTM) proposal is based on the concept that the USACE would select regional universities to provide state-of-the-art training and instruction in remote sensing technology and applications. While the training would be listed within the PROSPECT system, it is anticipated that enrollment and final scheduling would be accomplished by the university on a regional basis, thereby adding flexibility to the PROSPECT programming process.

Other anticipated advantages to the UTM concept include the freeing of USACE training assets for other in-house training and the inclusion of up-to-date equipment, techniques, and applications. It is also anticipated that the concept will encourage interaction on a regionalized basis between USACE personnel and university based research scientists and educators. Such interaction, along with attendance at university seminars, participation in professional society meetings, etc., will permit RSC and other designated Corps personnel to keep abreast of new developments in the field and to maintain their interest and proficiency in remote sensing.

D. Guidelines for University Training Modules

1. Structure and Staffing Requirements for the University

Five universities would be identified as regional training centers by USACE. Each would have strong, well staffed, engineering based hydrology and water resources instructional programs and an active, water resources oriented remote sensing research program.

The participating universities must be able to dedicate qualified staff in sufficient numbers if the modules are to be successful. Because the emphasis is upon the application of remote sensing to water resource problems it is important that the staff involved in the workshop have recognized competence in both of these areas. It may be that a particular university can meet this requirement by using a team approach to teaching or by bringing in outside consultants to supplement their staff.

Because instruction in the short course format is an extremely intense effort, the participating university must allocate at least two professional level personnel to the program. There must also be at least two fully trained assistants, who might be advanced level graduate students, available to work with the participants during the workshop sessions. There must be sufficient hardware/software support personnel available to insure that all of the equipment being used functions properly throughout the course. Finally, sufficient administrative support must be allocated to handle communications in advance of the course and management of local arrangements.

When student capacity exceeds USACE needs, training will be offered to personnel from other Federal agencies, contractors, and state/local governments on a reimbursable basis. Such allocation follows the letter of the National Research Council recommendations previously cited.

2. Syllabi and Conduct of Training

Providing only very general guidelines on material to be covered and the conduct of training is an inherent aspect of the UTM concept. Over specification of either subject matter or format would defeat the spirit of academic freedom and innovation that is sought. On the other hand, there is a legitimate requirement for some level of guidance to the designated universities and there must be a feedback mechanism to assess the effectiveness of training.

Overall guidelines center on the incorporation of state-of-the-art operational technology with emphasis on the interfacing of digital image analysis and geographical information systems. Flexibility must remain to allow the tailoring of each course to meet the needs and experience of the class. It must be recognized that the allocated time will be insufficient for comprehensive treatment of the field. The instruction should be regarded as an indoctrination; most trainees will have to gain more experience before they can adequately apply the techniques covered. It is also not possible to cover all possible applications and the course should concentrate on a limited number (Rib, 1981). Providing a variety of application areas for hands-on training will maintain interest and enthusiasm (Hill, 1981).

The material presented will be selected to allow Corps of Engineers personnel at the appropriate managerial/technical level to determine:

- When digital format remote sensing and geographical information systems would be advantageous in meeting the objectives of a particular project;
- What sensor systems and methods of interpretation would be required;
- What should be expected with respect to problems to be anticipated, quality of information, time and cost requirements;

- What should be included in the scope of work and performance specifications;
- What are the required technical qualifications of personnel that would be involved;
- What should one look for in the organizational and equipment qualifications of the consultant; and
- What is involved in guiding and monitoring the work of the consultant.

The syllabi of the currently listed PROSPECT courses, the NASA training program, and short courses conducted by numerous universities have been reviewed to develop general guides for subject matter for two recommended UTM. Summaries of the courses reviewed are included as Appendix B. Topical coverage was found to be reasonably consistent among the courses considered and specific topics can be fairly easily grouped into general subject areas:

- Physical foundations
- Spectral characteristics of earth surface features
- Sensors and platforms
- Digital data acquisition and processing
- Digital image analysis
- Geographic information systems
- Applications
- Data analysis workshops

Most courses designed as "fundamental" or "advanced topics" used five training days. While the USACE RS-Manager course has three training days, the University of Kansas reports good results from one day orientation courses conducted under NASA sponsorship in 1981 (Martinko and Williams, 1981).

The training needs of the Corps can be met by designating two training modules, a Remote Sensing Manager course of two working days, and a Remote Sensing Technology course of five working days. Both will include material from each of the general subject areas previously cited. The two modules will, of course, differ in the scope and depth of coverage, as well as the distribution of time between the general subject areas. Specialized training for individuals who will be manipulating digital data or supervising consultants retained for image analysis will be provided through additional hands-on workshop activities as a part of the Remote Sensing Technology module.

Assignment of specific topics under each general subject area is at the discretion of the host university. It must be remembered that these modules are not for a broad audience; rather, they are to be specifically tailored for water resources specialists who need information that can be applied directly to their problems. Thus, the material presented must center on hydrologic/water resource applications and, therefore, should include reviews of hydrologic models with emphasis on the translation of remotely sensed data into quantitative information required for water related decision making. Although individual universities must have the flexibility to design the details of the modules to reflect their own strengths and particular situations, Tables 1 and 2 can serve as a guide to the general topics required to meet the needs of water resources specialists.

Consideration should be given to conducting a module near, but not at, the location of a large number of trainees from the same field office (Rib, 1981). It should be noted that the course could be conducted at a hotel or other training oriented facility near enough to avoid per diem, travel and the need for participants to stay overnight. However, it should not be conducted within the

TABLE 1. RECOMMENDED TOPICS FOR REMOTE SENSING MANAGER COURSE

DAY ONE

- Objective of course
- Overview of computer based remote sensing/GIS capabilities for water resource analysis
- Digital format sensor systems and their interpretations through computer aided techniques
- Demonstration of Color CRT based image processing system
- Trade-off among sensor accuracy, economics, sensitivity of analytical tools and sesnitivity of final decisions to quality of information

DAY TWO

- Structure and applications of geographical information systems with emphasis on current USACE systems
- Demonstration of terminal accessed, mainframe-based USACE GIS
- Trade-offs between in-house and consultant supplied remote sensing/GIS services
- Summary
- Critique

TABLE 2. RECOMMENDED TOPICS FOR REMOTE SENSING TECHNOLOGY COURSE

DAY ONE

- Objective of course
- Review of Remote Sensing compatible USACE hydrologic models and water resource inventory requirements
- Overview of computer based remote sensing/GIS capabilities for water resources analysis
- Foundations for digital format remote sensing
- Sensor systems

DAY TWO

- Spectral signatures
- Computer aided image analysis I
- Computer processing/analysis workshop I

DAY THREE

- Computer aided image analysis II
- Computer processing/anlaysis workshop II
- Translation of sensor data into water related information
- Computer processing/analysis workshop III

DAY FOUR

- Geographical Information Systems
- Computer processing/analysis workshop IV
- Remote sensing-ancillary data-GIS interfacing
- Computer processing/analysis workshop V

DAY FIVE

- Computer processing/analysis workshop VI - A comprehensive exercise simulating the steps invovled in a USACE watershed study
- Summary
- Critique

offices because of the risk of participants being called out for imagined emergencies, conferences and advice. A concept of customizing courses has been developed by Davis and Bartolucci (1981) and might prove advantageous and cost efficient under the proper circumstances.

The UTM concept includes the use of advance study material, a self-administered pre-course examination, and a personal experience questionnaire to be completed and returned by all trainees. Lecture outlines and references will be provided at the time of instruction. A self-administered examination will conclude each course, along with recognition of course completion in the form of a training certificate.

The use of pre-course reveiw assignments to be completed and mailed in prior to the class has been effectively employed in many training programs at the USACE Hydrologic Engineering Center (HEC). HEC uses such material to avoid spending class time on basic concepts and to appraise instructors of student backgrounds and comprehension of basic concepts (HEC, 1981).

The responsibility of the university does not end, however, with the conclusion of the original formal training period, but extends for a finite period, perhaps two or three years, to be determined by negotiation. During this sustaining period, each trainee will receive update and refresher information through newsletters published by the university, will be invited to attend seminars and scholarly meetings sponsored by the university, and can call upon university personnel for a reasonable amount of technical assistance with remote sensing applications.

3. Supporting Materials

In keeping with the themes of academic freedom and innovation, it is inappropriate to specify mandatory textbooks or references for UTM. It is

anticipated, however, that the principal references used will be the Remote Sensing Application Guide (USACE EP 70-1-1, 1979). The Landsat Tutorial Workbook (NASA RP-1078, 1982), Remote Sensing: The Qunatitative Approach (Swain and Davis, 1978), Remote Sensing and Image Interpretation (Lillesand and Kiefer, 1979), Manual of Remote Sensing (American Society of Photogrammetry, 1983), and the Proceedings of the USACE Remote Sensing Symposia (USACE, 1979a and 1982). Universities will quite properly choose to include the published works of their own faculty and other general works published subsequent to this writing. An excellent source of audio visual materials is the remote sensing minicourse series developed and distributed by LARS, Purdue University.

4. Integration of Data Analysis and Information Systems Management

All training will include instruction and some level of hands-on manipulation of digital data, pattern recognition or classification and use of a geographic data base management system. Coverage in the manager module is necessarily minimal, but that of the technology module is sufficient to provide a comprehensive indoctrination to the techniques involved. The individuals who complete the optional additional data analysis workshop periods will be sufficiently trained to evaluate contractor work in classification and other forms of data analysis.

The application of modern remote sensing technology is hardware/software intensive. Thus, it is mandatory that the participating university have the proper computer equipment and related software if the program is to be successful. These hardware/software systems must be state-of-the-art with respect to image processing, GIS, and water resource applications.

Participants must have meaningful exposure to a minicomputer supported Image Display and Processing System (IDPS) on which the image processing

centers around a color cathode ray tube. This IDPS would be representative of the type of equipment that the participants might require of a consultant who would be retained to conduct image processing on a particular project.

In other instances, the consultant or the USACE field office might elect to conduct image processing through the use of a remote terminal accessing software via telephone lines connected to a mainframe central processing unit. Thus, the participating university must have state-of-the-art software available on a mainframe computer with at least one desktop terminal for every two participants.

The ultimate objective in the use of remote sensing is to improve the quality of information available for the decisionmaking process. The interfacing of remotely sensed data with geographical information systems is a key element in improving the quality and the efficiency of the water resource related decisions. The subsequent interfacing of the information developed through the remote sensing/GIS operations with a hydrologic model significantly increases the power of the approach. In order to demonstrate these capabilities to the participants, the university must have the current USACE hydrologic models available on their computers or be able to access these models in a time-sharing mode. It will also be necessary for the university to have available the current version of at least one USACE geographical information system. Because these specialized packages may not be found in many university computer libraries, the USACE Requests for Proposals should include provisions that would support the implementation of these models and GIS. Naturally, the university will have whatever software is needed to insure the easy interfacing among sensor outputs, GIS and hydrologic models.

The period of training is quite short and, therefore, must be optimized toward the problems that the participants will be encountering. Thus, the imagery that will be used should be current and from the region in which the participants will be working. If all of the participants happen to be from a single district, the imagery used must be from that district. The university will insure that adequate supporting photography, topographic maps, and other resources necessary for ground truth will be available.

5. Costs

It is virtually impossible to estimate the dollar or man year costs associated with the UTM concept. Both personnel and equipment costs will vary widely depending upon the assets and experience of the individual universities selected as regional training centers.

There is no doubt that the modules will require each university to commit a significant amount of manpower and fiscal resources to professional planning and insuring the availability of suitable hardware and software, and a minor allocation of resources to support the sustaining phase of the concept. It is anticipated, however, that the cost of each module will not be significantly greater than the cost of the current PROSPECT training courses, as only the sustaining phase is a completely new feature.

A cost savings will result from the recommended deletion of the advanced processing course currently offered under PROSPECT. It is also anticipated that regional coordination of the modules will result in improved training utilization. These two factors may well result in lower training costs per individual trained.

III. REMOTE SENSING SYMPOSIUM

The 1981 USACE Remote Sensing Symposium was held November 30 to December 2, 1981, at the Radisson Plaza Nashville, in Nashville, Tennessee. There were 169 registered participants from the USACE, other government agencies, the academic community, and several commercial firms.

The University of Maryland was responsible for program support and logistical arrangements for the meeting. A separate report (RSI , 1981) has provided details on all coordination, arrangements, and financial matters.

Recommendations for improvement of the next symposium are as follows:

1. Increase advance publicity and distribution of Announcement and Call for Papers.
2. Conduct an optional, one-day (day prior) orientation course on Fundamentals of Remote Sensing. Many participants indicated an interest in such a course.
3. Expedite publishing of the Proceedings so as to distribute as soon as possible after the meeting.

IV. APPENDICES

APPENDIX A

REMOTE SENSING - MANAGER

138/WRSC-C
No. M4MRSM

Short Title - REMOTE SENSING - MANAGER

Course Length: 24 Hours; Location: Varied

PURPOSE

The course is designed for managerial personnel who are or will be associated with the applications of a relatively new technology, remote sensing, to problem areas where they play a decision-making role. The manager will be able to converse in the language of the technology and to understand the fundamental aspects of remote sensing, sensors, and application techniques. Photogrammetry will not be included.

DESCRIPTION

Topics to be covered in this course include: Fundamentals of remote sensing; e.g., description of light spectrum radiation, etc., a definition and description of sensors currently used in aircraft and satellite programs, an introduction to the use of probability and statistical functions in analyzing remotely sensed data, the need for "ground verification of data and ground truth techniques", nomenclature used in remote sensing work, and application of remotely sensed data. Visual aids and classroom demonstration of applications will be used to illustrate principles. Demonstrations will be based primarily on data from LANDSAT satellites.

PREREQUISITES

Nominees must be assigned:

a. Corps Stratification: Planning, *Environment & Studies (A-3); and Operations, *Resource Management (C-4).

b. Occupational Series: Selected 0400, 0800, and 1300.

c. Grade: GS-13 or above.

d. Other: Nominees should be assigned management responsibilities in areas of planning, engineering, or regulatory functions. No specific subject matter background is required.

REMOTE SENSING - FUNDAMENTALS

196/WRSC-C
No. P4MRSF

Short Title - REMOTE SENSING - FUNDAMENT

Course Length: 40 Hours; Location: Varied

PURPOSE

This is a lecture-lab demonstration course designed to provide an understanding of the fundamentals of remote sensing technology as it is applied to environmental phenomena. The course will stress the basics of remote sensing, including information about the nature of light and optics, the classical properties of electromagnetic waves and their interaction with matter, and a review of radiation heat transfer. The working principles of primary remote sensors will be discussed and will include an overview of sensors and sensor platforms. An introduction to weather and earth resources satellites will be included. Photogrammetry will not be included in this course.

DESCRIPTION

The course will be broken down into three parts:

The first part will deal with energy and matter relationships: a. Concept of force fields; b. geometrical optics; c. properties of electromagnetic waves; d. review of black body radiation laws; and e. energy-matter interaction and atmospheric interaction.

The second with the technical aspects of the primary sensors in operation: Electro-optical systems (non-photographic) a. radar imagers; b. passive microwave imagers; c. infrared, visible, and ultraviolet imagers; d. thermal scanners; and e. sonar.

And the third with the demonstration of data processing techniques, image interpretation, and techniques for optically enhancing, enlarging, and clarifying imagery. Demonstration of remote sensing applications a. land use, forestry, geography, geology, hydrology, meterology, oceanography, etc.; b. general discussion of COE problem areas with participants; and c. data bases.

PREREQUISITES

Nominees must be assigned:

a. Corps Stratification: Planning, *Planning & Reports #(A-1), Environment & Studies (A-3); and Operations, *Resource Management (C-4).

b. Occupational Series: Selected 0400, 0800, and 1300.

c. Grade: GS-07 thru 12.

d. Other: (1) Nominees are, or will be, involved in the acquisition interpretation and application of remotely sensed data. (2) This course is a prerequisite for Remote Sensing - Advanced Digital Image Processing and Analysis.

REMOTE SENSING - ADVANCED DIGITAL IMAGE PROCESSING AND ANALYSIS

194/WRSC-C

Short Title - ADV DIGITAL IMAGE PROCESS

No. P4MADIP

Course Length: 40 Hours; Location: Varied

PURPOSE

This is a course designed to provide advanced training and "hands-on" experience in processing and analyzing multispectral scanner data. The course provides considerable laboratory experience so that the students will acquire confidence in the use of digital data.

DESCRIPTION

The course briefly reviews the basic concepts of remote sensing and data handling techniques as they apply to the analysis of digitally recorded multispectral scanner data. Systems hardware, software, and procedures for their use are studied in detail. Problem analyses are demonstrated with preprocessed, scanned data sets. The personnel attending the course will be provided with the opportunity to work in a hands-on environment with assistance from the instructors as necessary. Subjects to be included in the Processing Laboratory are Landsat, NOAA (TIROS) and other Satellite data processing techniques; the statistical analysis of Landsat data, including pattern recognition and image classification, image processing hardware and image processing, geographic referencing, ground truth operations, data base development and applications, and interactive analysis.

PREREQUISITES

Nominees must be assigned:

a. Corps Stratification: Planning, *Planning & Reports #(A-1); *Environment & Studies (A-3); and Operations, *Resource Management (C-4).

b. Occupational Series: Selected 0400, 0800, and 1300.

c. Grade: GS-07 thru 12.

d. Other:

(1) Nominees are, or will be, involved in the acquisition, interpretation, and application of remotely sensed data.

(2) Attendance in a Remote Sensing Fundamentals Course or an equivalent experience, is required for this course. Some knowledge of data processing techniques would be helpful but it is not mandatory.

APPENDIX B

George Washington University, School of Engineering and Applied Science

Five-day Short Course in Remote Sensing Fundamentals,

REMOTE SENSING FOR GLOBAL RESOURCE APPLICATIONS: PRINCIPLES AND TECHNIQUES,

Scheduled for October 1982 (GWU, 1982)

Topical Outline

Overview of Electomagnetic Remote Sensing

Physics of Electromagnetic Radiation

Remote Sensing Systems

Remote Sensing Data Availability

Principles of Remote Sensing Image Formation

Principles of Image Analysis and Interpretation

Principles of Digital Enhancement of Image Data

Principles of Digital Classification of Image Data

Forestry Applications

Agriculture and Range Applications

Geologic Applications

Hydrologic Applications

Geographic Applications

Geographical Coding of Land Use Data

Land Use Applications

Future Trends in Remote Sensing from Space

Future Trends for Applications of Remote Sensing Technology for Global Resource Problems

Murray State University, Mid-America Remote Sensing Center

Five-day short course in Remote Sensing Fundamentals conducted

in conjunction with NASA Earth Resources Laboratory,

October 5-9, 1981 (MSU, 1981)

Course Outline

First Day

Introduction and Course Overview
Remote Sensing/Manual Interpretation
USGS/EROS Data Center
Digital Image Concepts and Techniques
Applications of Remote Sensing

Second Day

Pattern Recognition
Image Enhancement
Landsat Applications in Management and Planning
Soils Mapping Laboratory

Third Day

Introduction to Unsupervised Classification
Thresholds/Signatures/Point Cluster Analysis
Ground Truth/Training Sample Selection
Minerals Exploration Demonstration

Fourth Day

Refined Supervised Classification/Georeferencing
Classification Demonstration

Fifth Day

Geographic Information Systems
Grey-level Plots and Chromalin
Chromalin Demonstration
Digitzer/Plotter Demonstration

NASA, Eastern Regional Remote Sensing Applications Center

Five-day ERRSAC Remote Sensing Training Course

(ERRSAC, 1981)

Course Outline

First Day

Introduction and Overview
Major Principles of Remote Sensing
LANDSAT System Products, Image Interpretation
Image vs. Digital Image Processing
IDIMS Demonstration/Image Analysis

Second Day

Steps in LANDSAT Project
Spectral Reflectance Characteristics of Vegetation
TIC/Brouse Library
Statistics for LANDSAT Data Analysis
Self-Teaching Aids
Hands-on ASTEP

Third Day

Ground Truth and Training Site Selection
ASTEP
Spectral Characteristic of Earth Surface Features
Applications (1)

Fourth Day

ASTEP
GIS
Applications (2)
Accuracy Assessment

Fifth Day

Other Image Processing Systems
Ground Truth Field Trip
Review
Optional Time

Purdue University, Laboratory for Application of Remote Sensing

Standard Five-day Course in Numerical Analysis of Remote Sensing Data

(LARS, 1982)

Core Subject Areas

Introduction to and Background of Remote Sensing

Multispectral Sensors

Spectral Characteristics of Earth Surface Features

Pattern Recognition Applied to Remote Sensing

LANDSAT Data Analysis Workshop

Remote Sensing Applications (2)

Optional Units

Radiation Theory and Instrumentation

Photgraphic Systems

Remote Sensing Applications (Additional)

Data Processing

University of Georgia, Center for Continuing Education

Five-day short course in Remote Sensing Fundamentals
Conducted by the Department of Geography, University
of Georgia, and the Engineering Experiment Station,
Georgia Tech University, in cooperation with the
NASA Earth Resources Laboratory

January 19-23, 1981 (UGA, 1980)

Course Outline

First Day

Introduction
LANDSAT Program
Image Processing Concepts and Analysis Techniques
Digital Image Preprocessing and Enhancement, Classification and Data

Second Day

Applications in Earth Science
Supervised Classification of Land Cover/Use

Third Day

Supervised Classification (Continued)
Analysis of Accuracy and Reliability of Classifications

Fourth Day

Description, Demonstration and Hands-on Experience with Image Analysis Hardware

Fifth Day

Data Display and Comparison with Photographs
Merits of Landsat Classification and Image Enhancement Techniques
Geographic Data Base

University of Kansas Applied Remote Sensing (KARS) Program

One-day and Five-day Short Courses in Remote Sensing Fundamentals

Conducted under NASA Contract in 1981

(Martinko and Williams, 1981)

One-Day Short Course Topics

Overview of Remote Sensing

- The Electromagnetic Spectrum
- Remote Sensing Platforms
- Remote Sensing Systems

Interpretation and Use of Remote Sensing Data

- Manual Interpretations
- Digital Interpretations
- Collateral Data

Remote Sensing Applications

- Planning
- Agricultural

Sources of Remote Sensing Data

Five-Day Short Course Topics

Introduction to Remote Sensing

- Physical Principles of Remote Sensing
- Remote Sensing Systems and Platforms
- LANDSAT

Manual Image Interpretation

- Interpretation of Aerial Photography
- Analysis of LANDSAT Imagery

Numerical Analysis of LANDSAT Data

- Supervised Classification
- Unsupervised Classification

Field Data Collection in Support of Remote Sensing

Applications of Remote Sensing

Geographic Data Bases

Acquisition of Remote Sensing Data

V. REFERENCES

American Society of Photogrammetry, Manual of Remote Sensing, 2nd Edition, Falls Church, VA, 1983.

Davis, D.W., "Corps Activities in Spatial Data Management," Proceedings of the 1981 USACE Remote Sensing Symposium, USACE, Washington, 1982, pp. 8-23.

Davis, S.M. and Bartolucci, L.A., "Customized Remote Sensing Short Course," Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, West Lafayette, IN, 1981, pp. 93-99.

Fellows, J.D. and Ragan, R.M., "A Data Base System for Real Time Hydrologic Modeling," Proceedings of the Civil Engineering Application of Remote Sensing Specialty Conference, ASCE, Madison, WI, August 1980.

Gay, F.T., "Keynote Address: Today's Challenge with Remote Sensing Technology," Proceedings of the 1981 USACE Remote Sensing Symposium, USACE, Washington, 1982, pp. 3-10.

George Washington University (GWU), Announcement for Course 488DC, "Remote Sensing for Global Resource Applications: Principles and Techniques," Course dates - October 18-22, 1982, School of Engineering and Applied Science, Washington, DC, June 1982.

Hill, J.M., "Federal and State Short Courses Offered by RSIP at Louisiana State University," Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, West Lafayette, IN, 1981, pp. 152-155.

Hydrologic Engineering Center (HEC), Course Notes for Short Course, "Hydrologic Analysis of Floods," August 10-14, 1981, USACE, Davis, CA, 1981.

Jarman, J.W., "Program Overview," Proceedings of the 1981 USACE Remote Sensing Symposium, USACE, Washington, 1982, pp. 1.

Martinko, E.A. and Williams, T.H.L.,"Remote Sensing Short Courses in Kansas," Space Technology Center, University of Kansas, August, 1981.

Moore, G.K., "Processing Capabilities for Hydrologic Information Systems," Proceedings of the 1981 USACE Remote Sensing Symposium, USACE, Washington, 1982, pp. 114-130.

Laboratory for Applications of Remote Sensing (LARS), Course Notes for Short Course, "Remote Sensing Fundamentals," March 23-27, 1981, Purdue University, West Lafayette, IN, 1981.

_____, Course Notes for Short Course, "Remote Sensing - Advanced Digital Image Processing and Analysis," May 4-8, 1981, Purdue University, West Lafayette, IN, 1981a.

_____, Announcement for Course, "Numerical Analysis of Remote Sensing Data," as amended by personal letter from Training Coordinator, Purdue University, West Lafayette, IN, 1982.

Lillesand, T. and Kiefer, R.W., Remote Sensing and Image Interpretation, Wiley, NY, 1979.

Murray State University (MSU), Announcement for Course, "Application and Processing of Landsat Data," Course dates October 5-9, 1981, Mid-America Remote Sensing Center, Murray, KY, 1981.

NASA, Course Notes for Short Course, "ERRSAC Remote Sensing Training Course," June 8-12, 1981, NASA-GSFC, Greenbelt, MD, 1981.

_____, Landsat Tutorial Workbook (NASA RP-1078), GPO, Washington, 1982.

National Research Council (NRC), "Remote Sensing for Water Resources and Hydrology: An Assessment of the Corps of Engineers Program," Panel on Remote Sensing for Water Resources, Space Application Board, National Academy Press, Washington, 1981.

Ragan, R.M., "Use of Remotely Sensed Data in Hydrologic Models," Proceedings of the 1981 USACE Remote Sensing Symposium, USACE, Washington, 1982, pp. 11-23.

Rib, H.T., "Experiences in Presenting Remote Sensing Short Courses in the Transportation Fields," Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, West Lafayette, IN, 1981, pp. 146-151.

Remote Sensing Systems Laboratory (RSSL), "U.S. Army Corps of Engineers Remote Sensing Symposium: Final Report," University of Maryland, College Park, MD, December 1981.

Swain, P.H. and Davis, S.M. (Eds.), Remote Sensing: The Quantitative Approach, McGraw-Hill, New York, 1978.

University of Georgia (UGA), Announcement for Course, "Recent Advances in Remote Sensing," Course dates January 19-23, 1981, Center for Continuing Education, Athens, GA, 1980.

USACE, Remote Sensing Applications Guide (Engr. Pam 70-1-1), Department of the Army, Washington, October 1979.

_____, Proceedings of the 1979 USACE Remote Sensing Symposium, USACE, Washington, 1979a.

Weinstein, R.H., "Remote Sensing Education in NASA's Technology Transfer Program," Proceedings of the 1981 Conference on Remote Sensing Education, Purdue University, West Lafayette, IN, 1981, pp. 316-320.